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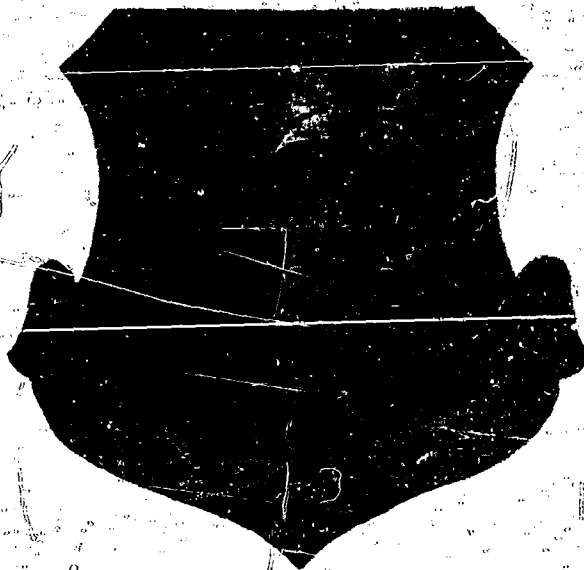
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**AIR FORCE ARMAMENT CENTER**

TECHNICAL REPORT NO. 53-42



**AIR RESEARCH AND DEVELOPMENT COMMAND**

**ENGINEERING EVALUATION OF TYPE T 160 GUN  
AND INSTALLATION IN F 86 AIRCRAFT**

SEPTEMBER 1953

COPY NO. 46 OF 105

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AFAC TECHNICAL  
REPORT 53-42


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SECURITY INFORMATION

PROJECT "GUN-VAL"

Supplementary Project  
ENGINEERING EVALUATION OF TYPE T160 GUN AND  
INSTALLATION IN F-86 AIRCRAFT

PUBLICATION REVIEW

This report has been reviewed and is approved.

  
EDWARD P. MECHLING  
Brigadier General, USAF  
Commander

AIR FORCE ARMAMENT CENTER  
Eglin Air Force Base, Florida

September 1953

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## ERRATA SHEET

### AFAC TECHNICAL REPORT 53-42

#### Engineering Evaluation of Type T160 Gun and Installation in F-86 Aircraft

1. On page iv, par. 3, lines 4-6, delete, ". . . the over-all stoppage rate obtained in the AFAC tests under conditions ranging from -1 to +4 1/2 "g" was 3.69 per thousand." Insert, ". . . the over-all stoppage rate, based on all rounds fired from the installation during the ground and aerial phases, was 3.52 per 1000 rounds fired."

2. On page 18, par. 1, lines 5 and 6, delete: "The average stoppage rate under conditions ranging from -1 to +4 1/2 "g" loading was 3.09 per thousand rounds fired." Insert: "The over-all stoppage rate, based on all rounds fired from the aircraft installation was 3.52 per 1000 rounds fired."

3. On abstract cards, par. 2, lines 1 and 2, delete: "The over-all stoppage rate was 3.6 per thousand rounds under conditions ranging from -1 to +4 1/2 "g". Insert: "The over-all stoppage rate, based on all rounds fired from the aircraft installation during the ground and aerial phases, was 3.52 per thousand rounds fired, . . ."

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The following people were responsible for the actual testing accomplished under this project. The Project Officers prepared the manuscript for this report.

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FOREWORD

This test, Air Force Armament Center Project E/W/20-1, was conducted as a part of Project "Gun-Val" under the authority of Headquarters, Air Research and Development Command, Test Directive No. 5033-E1.

ABSTRACT

This is a report of the engineering evaluation of a four-gun installation of the T160 20mm automatic weapon in the F-86F aircraft.

The T160 gun was fired from a rigid ground mount and from a stationary aircraft to determine barrel life, projectile velocity, projectile yaw, cyclic rate, dispersion, and aircraft installation reliability. The general functioning characteristics and the installation reliability, as well as the gun bay ventilating system, were tested by aerial firing up to altitudes of 40,750 ft.

Results indicate that the installation is generally reliable. That is, an average stoppage rate of 2.8 per thousand rounds is considered to be acceptable under combat conditions; the over-all stoppage rate obtained in the AFAC tests under conditions ranging from -1 to +4 1/2 "g" was 3.69 per thousand. However, it is recommended that further refinements of gun and parts be made, that the present link ejection chutes be redesigned to provide greater clearance for expended links, and that a higher standard of quality in the manufacture or design of barrels and seals be attained, with particular attention given to hardening the breech end of the barrel.

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INTRODUCTION

The test was initiated as a part of "Gun-Val," a project which was designed to determine, from a variety of foreign and domestic guns installed in USAF aircraft, the most desirable armament combinations for various types of fighter missions. The gun under test was developed by the Armour Research Laboratory, under contract with Wright Air Development Center, and produced by Ford Motor Company.

The purpose of this test was to evaluate four T160 20mm automatic guns installed, by North American Aviation, Inc., in an F-86F aircraft; the evaluation to be based upon stoppage rate, fire-out percentage, cyclic rate, dispersion, parts replacement rate, and maintenance requirements. The performance of the complete installation, rather than the basic gun only, was the major consideration.

DESCRIPTION

The T160 gun (Fig. 1) is a revolver-type, gas-operated, automatic weapon consisting essentially of a combination drum support and standard twist steel barrel, a rotating drum with five chambers, a spring-loaded operating slide, and a gas-operated piston. It is electrically fired and belt fed and can be adapted to either right or left hand feed. The weight of the basic gun, without charger, charger cylinder, and gas line, is 171.2 lb; over-all length is 72 3/8 in.; height is 8 1/4 in.; and width, with cartridge ejection chute, is 10 in. The total weight of the four-gun T160 armament installation is 1348 lb, as compared with the 1179-lb standard six-gun cal .50 M3 installation.

Four T160 model FX3 guns, two on each side of the fuselage, were mounted in each of two test aircraft, as shown in Fig. 2. Provision was made for the storage of ammunition and links before firing and link storage after firing. (Links were retained in the aircraft in order to maintain cg control.) Case ejection chutes were utilized to eject the spent cases from the aircraft.

Each gun bay was equipped with an identical gun-gas purging system. The system consisted of a pneumatically-operated, electrically actuated air inlet door which opened into the engine air intake duct, acting as a ram air scoop when fully opened. The inlet door opened upon depression of the firing trigger and remained open for 5 sec after trigger release.

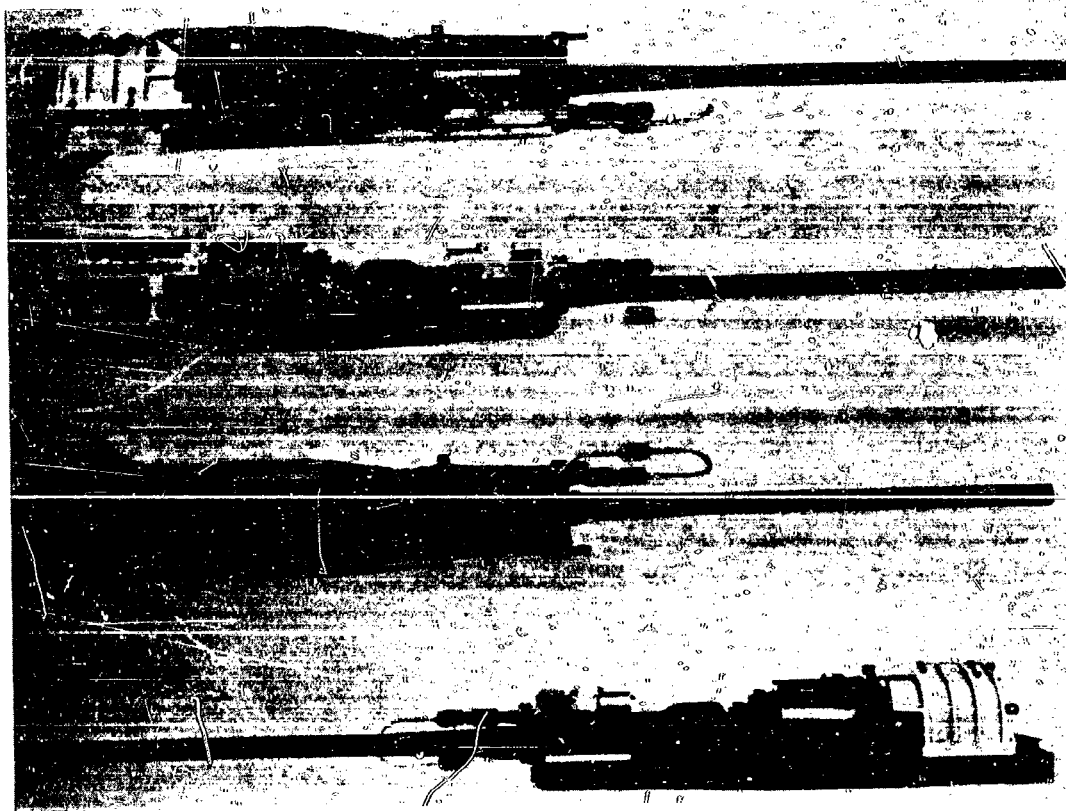


Fig. 1: The T160 Gun

Two 15.8 sq in. inlet holes and four small openings (two 1 3/8 sq in. in area and two 1 1/2 in. in diameter) were provided in the engine air intake duct. Exit openings were provided by two horizontal slots and five small holes (1 1/2 in. in diameter) in each gun bay door. Additional ventilating holes were provided in the fuselage skin in the areas of the link retention and ammunition box compartments.

Access to the guns was facilitated by a mounting yoke at the forward end of the receiver. After the barrel was removed and the rear mounting lugs loosened, the gun could be pivoted as shown in Fig. 3 and serviced in that position.

The ammunition used was 20mm T165 ball 60/20 practice rounds. The installation was capable of carrying 115 rounds per gun.



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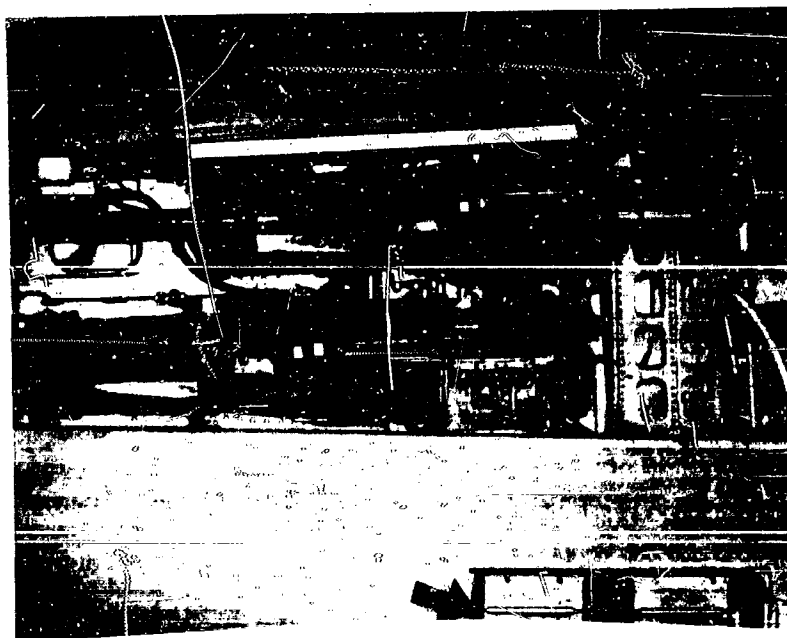


Fig. 2: T160 Guns Installed in F-86F Aircraft. In lower view,  
black arrow indicates ammunition compartment and white  
arrow shows case ejection chute.

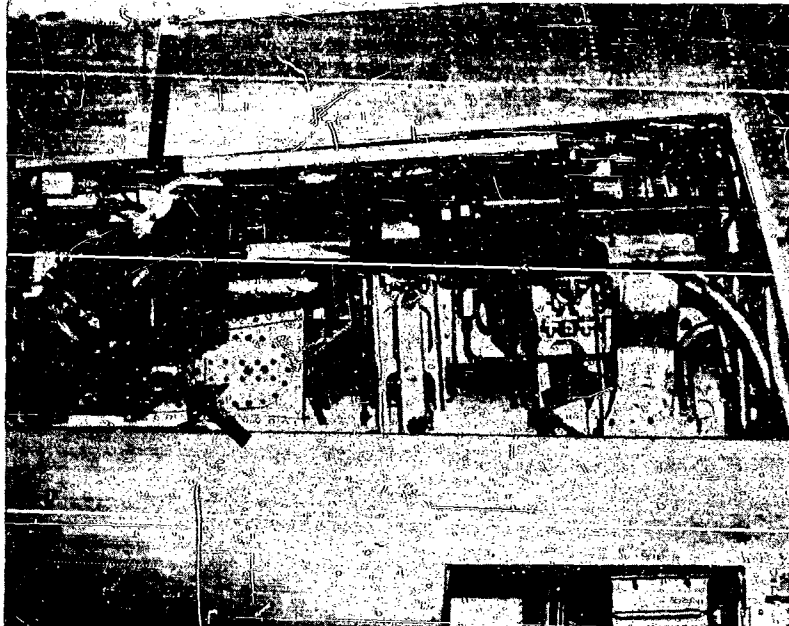


Fig. 3: In This View, the Lower Left Gun has been Pivoted for Ease of Maintenance (left arrow), while the Upper Gun is in Normal Position. Note link ejection chuting for upper gun (right arrow).

## INSTRUMENTATION

### GROUND FIRING PHASES

Major components of instrumentation required for ground firing of the guns mounted on both the aircraft and on the rigid mount were a recording oscillograph, a counter chronograph, and lumiline screens.

Cyclic rate of fire was determined by utilizing the oscillograph, which was actuated by pulses from the firing circuit. Projectile velocity was recorded on the counter chronograph, which measured the time required for a projectile to pass through two lumiline screens 50 ft apart.

### AERIAL FIRING PHASE

Two 16mm GSAP cameras were located on the wing tanks of both test aircraft to provide photographic coverage of the area forward of the nose to aft of the gun bay. A third GSAP camera was located at the lip of, and directed into, the engine air intake duct to detect flaming within the duct.

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Fig. 4: Mechanical Pick-Up for Recording Cyclic Rate of Fire. Arrows indicate brushes.

This camera also recorded the functioning of the air inlet door of the gun-gas purging system.

Instrumentation to determine cyclic rate of fire was installed in one aircraft. An aluminum brush (Fig. 4) was used to open and close a circuit as the gun cylinder rotated, creating, across a resistor, a voltage drop which was recorded by a Midwestern Model 555 oscillograph mounted in the left wing tank (Fig. 5). A timing circuit inside this oscillograph supplied the time base.



Fig. 5: Battery Overflow, Power Supply, and Oscillograph (left to right) Mounted in Left Wing Tank of One Test Aircraft

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A vacuum bottle gun-gas sampling system, a "fire-eye" fire detection system, and two pressure gauges were located in the other test aircraft for a gun-gas purging system test.

The two guns in the left gun bay were removed to furnish space for the vacuum bottle gun-gas sampling system. This system consisted primarily of 10 pyrex bottles, mounted as shown in Fig. 6. The two guns in the right bay furnished gun-gas samples. Individual sampling tubes were led, one to each bottle, from those locations in the right gun bay where it was considered that the greatest gas concentrations were likely to occur during firing (Fig. 7). One sampling tube was led from a location in the engine air intake duct.

The "fire-eye" fire detection system was installed to determine the amount of flaming in the right gun bay. The output signal of the "fire-eye" amplifier was recorded on the oscillograph. Two of the "fire-eye" indicators are shown in Fig. 7.



Fig. 6: Mounting of Gun-Gas Analysis Sampling Bottles  
in Left Gun Bay

The two pressure gauges, located in front of the fire wall in the nose of the aircraft, were designed to give indication of reverse purging. The static side of each gauge was connected to a common copper tube, which terminated in the gun bay at a point where turbulence appeared to be unlikely. The head side of the left gauge was connected to a tube which terminated directly in front of the purge door in such a way that a reversal of air flow would cause a positive pressure on the gauge. The other gauge was connected in the same manner to a point in front of the ram scoop.

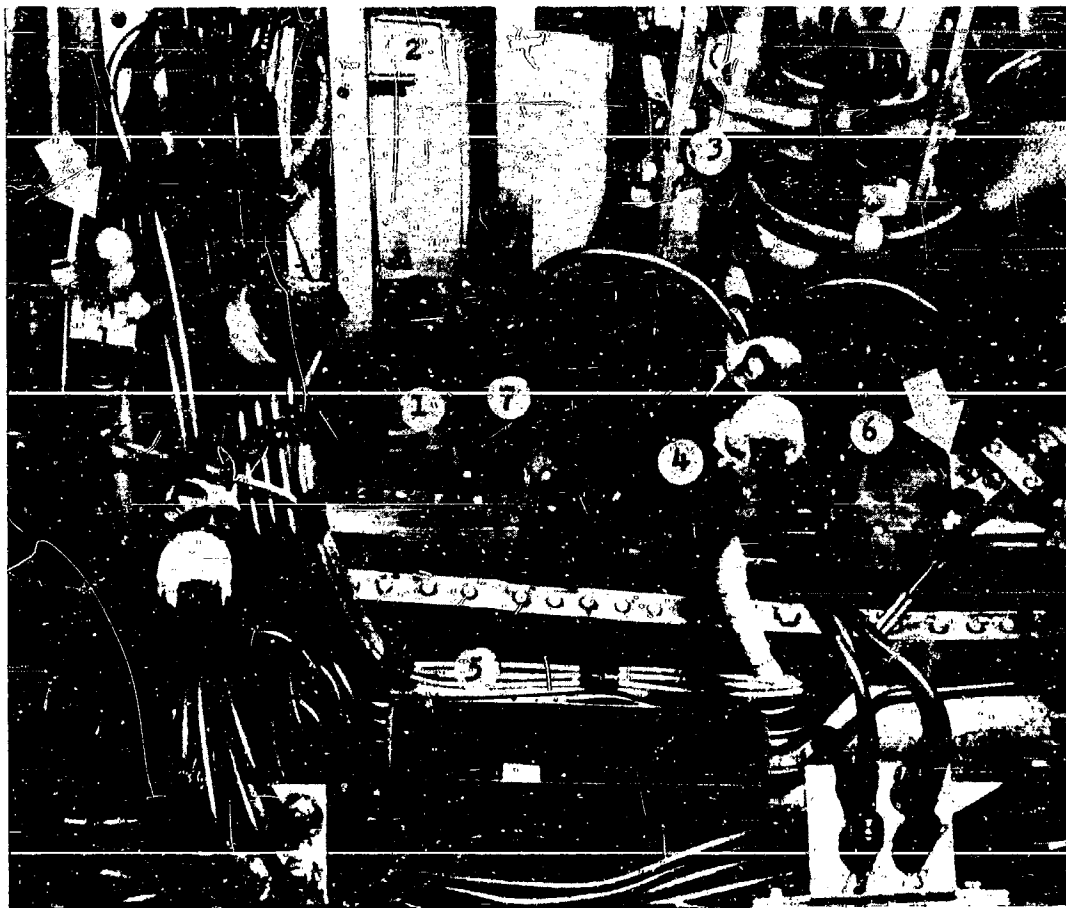


Fig. 7: Location of Gun-Gas Pick-Ups (numbers) and Fire-Eye Indicators (arrows) in the Aft Portion of Right Gun Bay. Two pick-up points in the gun bay, in addition to the one in the air intake duct, are not shown.

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TABLE 1. CAUSES OF GUN STOPPAGES DURING ALL PHASES OF TESTING

	<u>Ground Phase</u>		<u>Aerial Phase</u>		
	<u>Rigid</u>	<u>A/C on</u>	<u>Relia-</u>	<u>Gun</u>	<u>Total</u>
	<u>Mount</u>	<u>Ground</u>	<u>bility</u>	<u>Gas</u>	
<b>Ammunition</b>					
Defective primer	2				2
Defective or deformed case	2				2
Long or short round	2				2
De-bulleted round			1		1
<b>Gun</b>					
Firing circuit	2	2	3		7
Tolerances	1				1
Broken parts	24	8	6	1	39
Worn, weak, deformed parts	7	3	6	6	22
Improper functioning	3	1			4
<b>Installation</b>					
Ammo feed chutes	1			1	2
Link chutes		1	2		3
Gun mounts	1				1
Links--Broken, Weak, Deformed	2	1	3		6
<b>Personnel</b>					
Improper linking of ammo	2		1		3
Improper loading, handling	1				1
Improper maintenance		1			1
Link Jam in Feeders	2	6	9	1	18
Undetermined	7	2	1		10
TOTALS.....	59	25	32	9	125

## TEST PROCEDURE AND RESULTS

### RIGID MOUNT PHASE

A total of 15,140 rounds of ammunition was expended during this phase of testing to determine barrel life, projectile velocity, keyholing (indication on the target of projectile yawing), and cyclic rate. A total of 59 stoppages occurred, 31 of which were due to broken, worn, weak, or deformed gun parts and two to link jams in feeders. (See Table 1.) The average stoppage rate was 3.9 per thousand rounds fired.

Barrel Life. The major portion of testing during the Rigid Mount Phase was designed to determine barrel life; however, because of inconsistencies arising from insufficient hardness of the barrel breech, it was impossible to determine a definite life figure. The major cause of barrel failure, which together with wear of seals caused the greatest number of gun failures (Table 2), was high-pressure erosion of the breech end. Average life of barrels which failed as a result of erosion under burst length and cooling periods which were most representative of aerial firing was 750 rounds, with no failure occurring at less than 426 rounds. Maximum barrel life is considered to be reached when projectile velocity drops more than 200 ft/sec from the initial velocity.

TABLE 2. GUN PARTS THAT FAILED \*

<u>Part</u>	<u>No. of Failures</u>	<u>Part</u>	<u>No. of Failures</u>
Barrel	18	Barrel latch retainer	3
Seals (set of 5)	16	Switch cam slide	3
ADF spring	15	Rammer	3
Firing circuit assy	12	Drum assy	2
Gas piston	6	Barrel orifice	2
Firing pin & anvil assy	6	Rammer slide mounting screws	2
Drum cradle	5	Feeder housing	1
Cam insert	5	Operating slide	1
Round retainer pawl	5	Drum shaft	1
Switch tongue follower	4	Extractor striker	1
spring		Extractor spring screw	1
Link track extensions	4	Switch tongue cam	1
Feeder link ejection chute	4	Drum shaft latch retainer	1
Firing blade insulator	3		
		Total.....	126

\* Each failure did not necessarily cause a gun stoppage.

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Projectile Velocity. Projectile velocity was determined from samples of 10 consecutive shots, with each sample being taken at 130-round intervals during the expenditure of 11, 198 rounds of ammunition. The velocity was measured as the time required for the projectile to pass through two lumiline screens 50 ft apart, the first of which was 20 ft in front of the muzzle of the gun. The average projectile velocity was 3179 ft/sec. Maximum variation was 3.56%.

Key-Holing. After each determination of projectile velocity, two 65-round bursts were fired, with a 10 min cooling period between bursts, to determine the extent of projectile yawing (key-holing). Targets were inspected after each burst. Key-holing was not noticed until approximately 2000 rounds had been fired through barrels which had not already been replaced because of excessive erosion.

Cyclic Rate. To determine cyclic rate of fire, five 20-round bursts were fired through each of three barrels. The average cyclic rate for the 300 rounds fired was 1396 rounds per minute, with a maximum variation of 5.6%. It was determined at this time that the cyclic rate could be increased by re-drilling the barrel orifice to 0.199 in. in diameter. At the same time, by freeing the switch tongue and pivot, and grinding the drum roller mounting boss flush with the drum, reduction in drag and friction of these two parts was accomplished.

#### AIRCRAFT GROUND MOUNT PHASE

Installation reliability, projectile velocity, dispersion, and cyclic rate were determined during this phase of testing. A total of 9665 rounds was fired.

Installation Reliability. General reliability of gun operation was determined by firing magazine capacity loads in bursts of 1, 2, and 3 sec, with a 15-sec cooling period between bursts. New barrels were installed prior to each increase in burst length. A total of 25 stoppages occurred, 11 of which were due to broken, worn, weak or deformed gun parts (Table 1), and 6 to link jams in the feeder. (A discussion of this type stoppage is found on page 14). The average stoppage rate was 2.58 per thousand rounds fired. Based on full complements loaded, 84.5% of the rounds fired-out.

Projectile Velocity. Projectile velocity was determined from samples of 10 consecutive shots, with each sample being taken at approximately 300-round intervals during the installation reliability test. The velocity was measured as the time required for the projectile to pass through two lumiline screens 50 ft apart, the first of which was 20 ft in front of the muzzle of the gun. The average velocity was 3267 ft/sec.



TABLE 3. RESULTS OF DISPERSION FIRING

Guns Fired Singly (all measurements are in mils)

Gun	<u>Systematic Error</u>		<u>Standard Deviation</u>		Radius 50% Circle
	<u>Vertical</u>	<u>Lateral</u>	<u>Vertical</u>	<u>Lateral</u>	
UL	1.37	1.45	1.48	1.81	1.81
LL	1.89	1.34	1.46	2.24	2.23
UR	1.30	1.42	1.60	1.79	1.98
LR	1.57	1.29	1.37	1.70	1.82
System	0.70	0.85	4.96	22.40	*

Guns Fired in Salvo

UL	1.24	1.58	1.45	2.06	2.10
LL	1.62	1.53	1.53	2.49	2.44
UR	1.34	0.91	1.70	2.07	2.23
LR	1.96	1.00	1.29	1.78	1.83
System	0.70	0.81	5.11	22.43	*

\* Radius of the 50% circle for the system was not determined because the spacing and location of the guns would make this figure meaningless. The standard lateral and vertical deviation tabulated for the system is an indication of the dispersion.

Dispersion. Dispersion tests were accomplished during the reliability phase. Thirty patterns were obtained from 1500 rounds fired. Guns were fired separately and in salvo. Average results, shown in Table 3, indicate the vertical and lateral systematic error, standard deviation and radius of the 50% circle.

Cyclic Rate. Cyclic rate of fire was determined during the reliability phase. The rate was adjusted to approximately 1500 rounds per minute by accomplishing the adjustments indicated as necessary during previous cyclic-rate firings. Average rate was 1510 rounds per minute. When guns were fired in salvo as compared with separate firings, a drop of 4.3% was noted in the cyclic rate.

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AERIAL FIRING PHASE

Equipment Functioning and Installation Reliability. Seventeen flights were conducted at altitudes of 7500 to 40,000 ft and at  $+4\frac{1}{2}$  to  $-1$  "g" load conditions. Each of four guns was loaded with 110 rounds of ammunition and the complement was fired in two bursts, the first of approximately 2 sec duration and the second until all ammunition had been expended or until a stoppage occurred. A total of 7480 rounds was loaded of which 5603 rounds were fired. Based on full complements of ammunition loaded, there was a 74.9% fire-out.

Cyclic rate of fire was also recorded during several of these flights. Gun adjustments, indicated as necessary during cyclic-rate firing in the Rigid Ground Mount Phase, were accomplished before firing. For 2852 rounds fired under various "g" loadings, the average cyclic rate was 1376 rounds per minute. Since normal cyclic rate-variation on a static mount was greater than the variation under different "g" loadings, no correlation between cyclic rate and "g" loading can be made.

With 32 stoppages occurring (Table 1), the average stoppage rate was 5.7 per thousand rounds fired. Fourteen stoppages were due to link ejection equipment, and 12 to broken, worn, weak or deformed gun parts. Of the 14 stoppages encountered while using the T61E2 and T61E3 links and associated link ejection equipment, nine were caused by link jams in the feeder. It was found in many cases that when the round entered the feeder the link-ears failed to engage the front and rear guide tracks. As a result, the link-ears would either be sheared from the link, causing a link jam in the feeder and often in the link ejection chuting as well, or would drop into the activating slide-ways and jam the slide.

Inspection showed several causes for failure of the link-ears to engage the guide tracks. In some cases the link stiffeners were loose, causing links to bind in the ejection chute, thus creating a jamming action extending into the feeder; this in turn prevented the link-ears from engaging the guide tracks, which caused shearing, and gun stoppage. It was also found that the diameter of the guide sprocket for the T160 gun was too small, causing pressure against the incoming round and link, which bent the link-ears and resulted in feeder jams. The cartridge guide sprocket for 27mm ammunition was substituted and it prevented further jams from this cause. Another source of trouble was that the links tended to rotate upon entering the ejection chute. This condition was remedied during testing by the addition of a special doubler to the guide track.

Gun-Gas Analysis. Before each flight to measure the effectiveness of the gun bay ventilating system, the 10 pyrex bottles installed in the left gun bay of one test aircraft were evacuated to 29 in. of mercury vacuum. Preflight checks were also made of the "fire-eye" indicator, oscillograph, recorder box, and cameras. Eighteen flights were conducted

TABLE 4. GUN GAS PURGING SYSTEM ANALYSIS -- FLIGHT TEST

Flt No.	Altitude (1000 ft)	IAS (knots)	Rods Fired	Average Cyclic Rate (rpm)	Sampling Time after Start of Firing (sec)	Gas Analysis Results - % IEL - Bottle No.									
						1	2	3	4	5	6	7	8*	9	10
1	40	220	110	1720	1.1	102	72	76	—	146	84	73	25	141	—
2	40	0.7 Mach	110	1600	2.0	119	150	146	200	135	147	106	51	48	115
3	41	195	110	1587	1.6	—	45	50	83	79	109	72	53	56	156
4	39	220	107	1524	1.0	—	127	72	190	108	57	36	51	24	112
5	39	200	15	1576	1.5	95	27	80	124	40	68	95	24	38	122
6	39	190	110	—	1.5	—	40	0	64	48	13	32	89	47	42
7	40	190	110	1493	1.5	87	75	68	99	116	60	54	52	63	—
8	40	200	110	—	1.5	120	62	84	66	44	72	73	55	38	22
9	40	200	54	1408	1.5	47	68	32	97	49	56	87	154	157	79
10	40	200	26	1385	1.5	97	64	48	84	52	81	33	38	35	90
11	40	210	110	62	1.5	60	81	43	56	33	111	56	58	63	19
12	10	150	58	1492	1.5	136	15	43	55	5	50	3	38	21	78
13	10	350	110	1500	1.5	19	—	18	62	24	60	16	2	21	40
14	20	150	110	1564	1.5	143	26	10	105	202	184	48	102	110	170
15	20	350	35	1512	1.5	52	24	0	63	34	22	48	13	57	71
16	30	150	110	1526	1.5	65	13	0	233	163	176	55	41	32	203
17	30	350	84	1579	1.5	102	22	34	131	75	176	70	44	70	110
18	30	150	110	1616	1.5	162	14	0	116	79	198	61	65	60	162
Average .....						98.2	57.5	44.6	113	78.5	98.4	58	53.2	60	99.4

\* Denotes bottle that sampled the air intake duct.

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at altitudes from 10,000 to 40,750 ft, with IAS of 150 to 350 knots.

The two guns in the right gun bay were loaded with 110 rounds of T154 ball 60/20 ammunition, and the complement was fired in two bursts, the first of approximately 2 sec duration and the second until all ammunition was expended or until a stoppage occurred. A total of 3960 rounds were loaded of which 3458 rounds were fired. Based on full complements of ammunition loaded, there was an 87.5% fire-out. Nine stoppages occurred (see Table 1), resulting in an average stoppage rate of 2.6 per thousand rounds fired. Seven of these stoppages were due to broken, worn, weak, or deformed gun parts, and one to a link jam in the feeder. During each flight, a timing device opened the bottle pet cocks at a specified interval after the firing circuit was closed. This interval could be varied from 1 to 3 sec at 1/2-sec intervals. When the bottles were opened, a sample of gas was trapped so that it could be used in subsequent measurement of the products of gun-gas combustion. It was found that a high concentration of gun gas (see Table 4) in excess of 100% LEL (lower explosive limit) was located at pick-up No. 4 (see Fig. 7). Locations 1 and 6 were also found to have continuously high concentrations of gun gas. The 100% LEL represents a calibration factor using propane in a standard atmosphere and does not necessarily represent an explosive mixture at all conditions of pressure and temperature. Flaming occurred on seven flights, but it is believed that this condition is to be desired in that the fire burns the gases before they have a chance to build up to a dangerous concentration. However, if during firing the breech end of the barrels should become severely eroded due to cracked seals, or if high-pressure swaging of the barrel should take place, additional gases would escape more rapidly than they could be purged with the present air-flow rate. The excessively high concentrations of gun gas could be ignited, thus causing an explosion. This occurred on two occasions. Excessive pressure from an explosion in the right gun bay, resulting from failure of the breech end of the barrel of both guns, buckled the gun bay door and cracked the main rib (Fig. 8). Over 650 rounds had been fired through both barrels at this time. Combustion gases and flame were ported directly into the gun bay under extreme pressures. Swaging of the breech face accounted for the failure of the lower gun, while erosion due to a cracked seal caused the upper barrel to fail (Fig. 9). During the entire aerial firing phase, barrels retired because of erosion and swaging had an average life of 661 rounds.

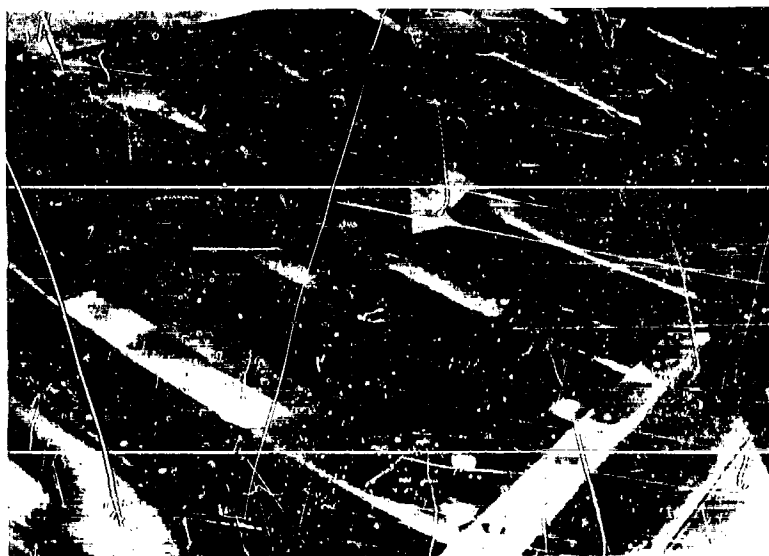
The two pressure gauges installed to indicate reverse purging did not function satisfactorily.

During gun-gas analysis flight No. 8, a large flash appeared approximately 2 to 3 ft in front of the muzzle of the upper right hand gun. The duration of the flash, shown in Fig. 10, was less than 23.44 milliseconds. (The flaming was much more in evidence during the original color film assessment when a definite difference could be noted between smoke and flash.) Gun-gas analysis results, shown in Table 4, indicated no unusual

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a. Arm on Door Buckled; Door Warped      b. Explosion Caused Buckling of Ribs



c. Aft Rib of Gun Bay Door Cracked

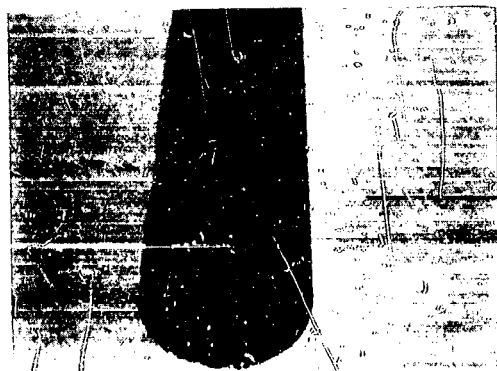
Fig. 8: Buckled Gun Bay Door and Cracked Main Rib Caused by  
Explosion in Right Gun Bay



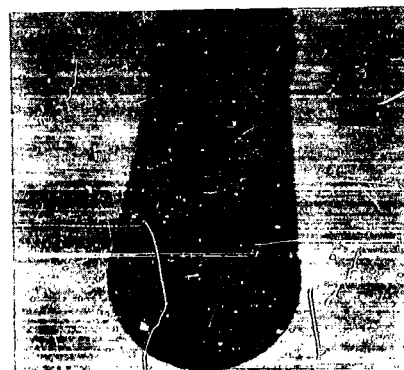
a. Cracked Seals from Upper Right Gun



b. Seal from Upper Right Gun



c. Erosion of Lower Right Gun



d. Erosion of Upper Right Gun

Fig. 9: Examples of Erosion and Swaging which Caused Gun Failures

concentrations of gun gases occurring during the sampling period for this flight.

Assessment of the film from the camera located at the lip of the engine air intake duct indicated that flaming occurred within the duct on several occasions. An average of 2 to 3 frames of film at a camera speed of 64 frames/sec were completely over-exposed during each firing pass on six of 11 flights attempted.

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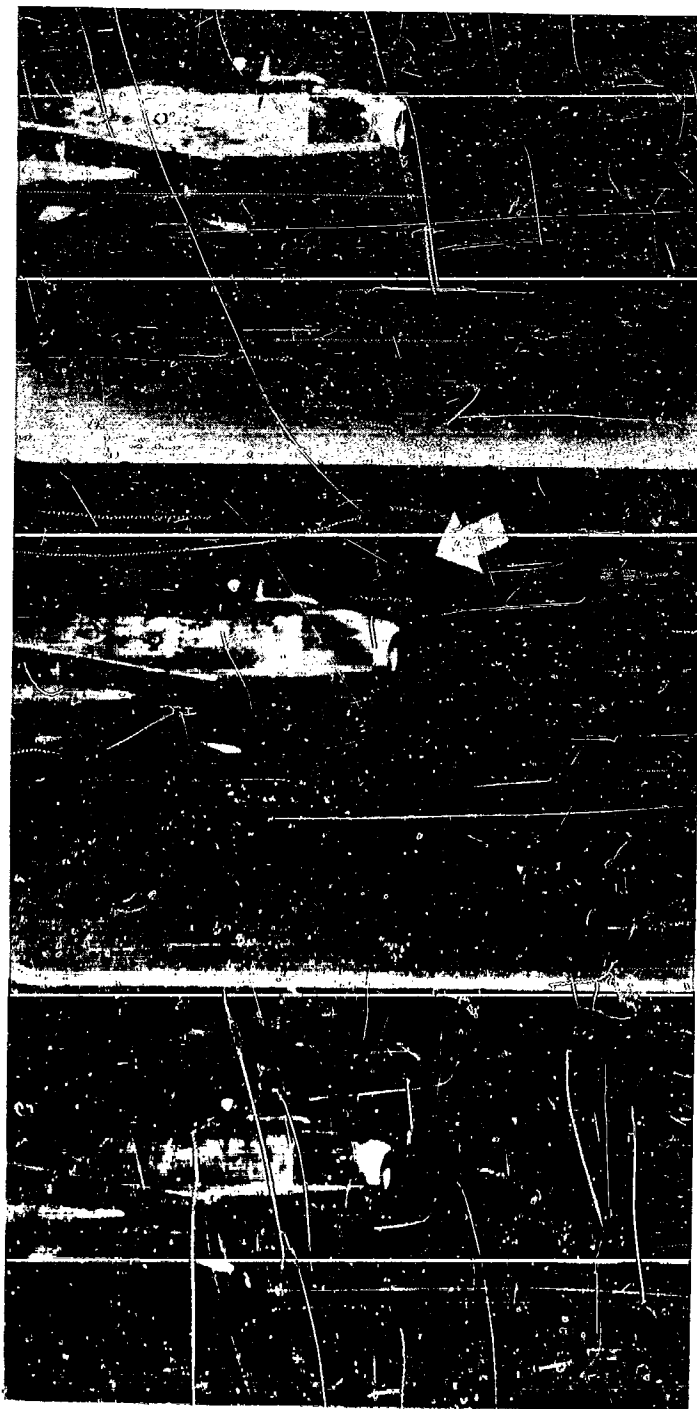


Fig. 10: Muzzle Flash During Gun Gun Flight No. 8

### CONCLUSIONS

The performance of the F-86F aircraft with T160 guns installed was generally reliable throughout the test program. A total of 18,718 rounds of ammunition was fired from the aircraft installation, with an over-all percent fire-out, based on full complements of ammunition, of 81.8%. The average stoppage rate under conditions ranging from -1 to +4 1/2 "g" loading was 3.09 per thousand rounds fired. (An average stoppage rate of 2.8 per thousand rounds is considered to be acceptable under combat conditions.)

Of the total number of stoppages, 58% were due to gun malfunctions. Wear of barrels and seals accounted for the greatest number of these failures (Table 2). By limiting the use of barrels and seals to 400 rounds of ammunition expended, this source of malfunction should be eliminated. Gun malfunctions could also be decreased by improving the design of the anti-double-feed switch spring and the firing circuit assembly to provide for longer parts life.

Attention should be directed toward improving the link ejection equipment, since 14.4% of the stoppages were due to link jams in the feeder and an additional 7.2% were caused by associated link failures.

It is concluded that the production control in the manufacture of barrels and seals is inadequate.

The present gun-gas data cannot be evaluated accurately since a reading of 100% LEL shows an explosive mixture only under conditions of a standard atmosphere. However, this data provides an indication of pockets of gas that are not properly purged.

### RECOMMENDATIONS

It is recommended that further efforts be made to improve the installation reliability. Attention should be given to the following:

1. Redesign of the link ejection chuting to provide more adequate clearances.
2. Control in the manufacture of barrels and seals, with particular attention given to hardening the breech end of the barrel so that it will have an initial standard hardness and will also maintain this hardness during



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gun firing for the expected life of the barrels.

3. Improvement in the firing circuit assembly by providing better support and insulation, thus reducing electrical shorting from breakage or condensation.
4. Improvement in the anti-double-feed switch spring to provide longer life.

It is also recommended that a continuing effort be made to establish a standardized system for gun-gas analysis.

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DEPARTMENT OF THE AIR FORCE  
HEADQUARTERS AIR FORCE MATERIEL COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE OHIO

FEB 19 2002

MEMORANDUM FOR DTIC/OCQ (ZENA ROGERS)  
8725 JOHN J. KINGMAN ROAD, SUITE 0944  
FORT BELVOIR VA 22060-6218

FROM: AFMC CSO/SCOC  
4225 Logistics Avenue, Room S132  
Wright-Patterson AFB OH 45433-5714

SUBJECT: Technical Reports Cleared for Public Release

References: (a) HQ AFMC/PAX Memo, 26 Nov 01, Security and Policy Review,  
AFMC 01-242 (Atch 1)

→ (b) HQ AFMC/PAX Memo, 19 Dec 01, Security and Policy Review,  
AFMC 01-275 (Atch 2)

(c) HQ AFMC/PAX Memo, 17 Jan 02, Security and Policy Review,  
AFMC 02-005 (Atch 3)

1. Technical reports submitted in the attached references listed above are cleared for public release in accordance with AFI 35-101, 26 Jul 01, *Public Affairs Policies and Procedures*, Chapter 15 (Cases AFMC 01-242, AFMC 01-275, & AFMC 02-005).

2. Please direct further questions to Lezora U. Nobles, AFMC CSO/SCOC, DSN 787-8583.

LEZORA U. NOBLES  
AFMC STINFO Assistant  
Directorate of Communications and Information

Attachments:

1. HQ AFMC/PAX Memo, 26 Nov 01
2. HQ AFMC/PAX Memo, 19 Dec 01
3. HQ AFMC/PAX Memo, 17 Jan 02

cc:  
HQ AFMC/HO (Dr. William Elliott)



# DEPARTMENT OF THE AIR FORCE

HEADQUARTERS AIR FORCE MATERIEL COMMAND  
WRIGHT-PATTERSON AIR FORCE BASE OHIO

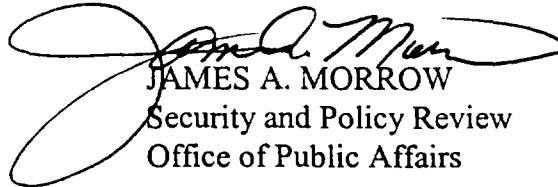
DEC 19 2001

MEMORANDUM FOR HQ AFMC/HO

FROM: HQ AFMC/PAX

SUBJECT: Security and Policy Review, AFMC 01-275

1. The reports listed in your attached letter were submitted for security and policy review IAW AFI 35-101, Chapter 15. They have been cleared for public release.
2. If you have any questions, please call me at 77828. Thanks.

  
JAMES A. MORROW  
Security and Policy Review  
Office of Public Affairs

Attachment:  
Your Ltr 18 November 2001

18 December 2001

MEMORANDUM FOR: HQ AFMC/PAX  
Attn: Jim Morrow

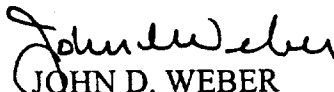
FROM: HQ AFMC/HO

SUBJECT: Releasability Reviews

1. Please conduct public releasability reviews for the following attached Defense Technical Information Center (DTIC) reports:
  - a. *Emergency Fuel Selector Valve Test on the J47-GE-27 Engine as Installed on F-86F Aircraft*, January 1955; DTIC No. AD- 056 013.
  - b. *Phase II Performance and Serviceability Tests of the F-86F Airplane USAF No. 51-13506 with Pre-Turbine Modifications*, June 1954; DTIC No. AD- 037 710.
  - c. *J-47 Jet Engine Compressor Failures*, 7 April 1952; DTIC No. AD- 039 818.
  - d. *Evaluation of Aircraft Armament Installation (F-86F with 206 RK Guns) Project Gun-Val*, February 1955; DTIC No. AD- 056 763.
  - e. *A Study of Serviced-Imposed Maneuvers of Four Jet Fighter Airplanes in Relation to Their Handling Qualities and Calculated Dynamic Characteristics*, 15 August 1955; DTIC No. AD- 068 899.
  - f. *Fuel Booster Pump*, 6 February 1953; DTIC No. AD- 007 226.
  - g. *Flight Investigation of Stability Fix for F-86F Aircraft*, 8 September 1953; DTIC No. AD- 032 259.
  - h. *Investigation of Engine Operational Deficiencies in the F-86F Airplane*, June 1953; DTIC No. AD- 015 749.
  - i. *Operational Suitability Test of the T-160 20mm Gun Installation in F-86F-2 Aircraft*, 29 April 1954; DTIC No. AD- 031 528.
  - j. *Engineering Evaluation of Type T 160 Gun and Installation in F 86 Aircraft*, September 1953; DTIC No. AD- 019 809.

AFMC 01-275

- k. *Airplane and Engine Responses to Abrupt Throttle Steps as Determined from Flight Tests of Eight Jet-Propelled Airplanes*, September 1959; DTIC No. AD-225 780.
  - l. *Improved F-86F: Combat Developed*, 28 January 1953; DTIC No. AD- 003 153.
  - m. *Flight Test Progress Report No. 19 for Week Ending February 27, 1953 for Model F-86F Airplane NAA Model No. NA-191*, 5 March 1953; DTIC No. AD-006 806.
2. These attachments have been requested by Dr. Kenneth P. Werrell, a private researcher.
3. The AFMC/HO point of contact for these reviews is Dr. William Elliott, who may be reached at extension 77476.

  
JOHN D. WEBER  
Command Historian

13 Attachments:

- a. DTIC No. AD- 056 013
- b. DTIC No. AD- 037 710
- c. DTIC No. AD- 039 818
- d. DTIC No. AD- 056 763
- e. DTIC No. AD- 068 899
- f. DTIC No. AD- 007 226
- g. DTIC No. AD- 032 259
- h. DTIC No. AD- 015 749
- i. DTIC No. AD- 031 528
- j. DTIC No. AD- 019 809
- k. DTIC No. AD- 225 780
- l. DTIC No. AD- 003 153
- m. DTIC No. AD- 006 806